Know Your Standards

Diversion ends

We were due to start looking at the monster multi-section standard IEC 61000-4 last time, but the New Legislative Framework intervened. IEC 61000-4 is a collection of Basic EMC standards (according to some, Parts 7 and 15 aren't Basic). There is a Section of IEC 61000-4 for every EMC susceptibility phenomenon (emission phenomena are covered by CISPR 16) and every method of measuring immunity that the EMC experts have found necessary or consider *might* be necessary.

What this means is that they address two groups, and this is important to understand, because an IEC 61000-4 series standard **does not** apply to a product unless the product or product-family standard has it as a Normative reference (not just an informative reference).

The first group is product (and product-family) EMC Committees. IEC 61000-4 says to them, 'If your product needs an immunity test method and one or more test levels for **this** phenomenon, make this Section a Normative reference in your standard, and select from its *recommended* test levels that or those which suit your product's intended environment'.

The second group addressed is those who want to carry out the tests. IEC 61000-4 says to them 'That's the way to do it.' In some cases, the instructions are rather too terse or opaque for comfort. They are almost always too costly for comfort!

IEC 61000-4-1

This is an overview of the whole 61000-4 series. It may be helpful for understanding *but it is not really a Basic standard ; no product can conform to it because it sets no requirements for a product.* It is almost entirely a guidance document, but it does set requirements for test reports, which is curious because so do most of the other Parts.

IEC 61000-4-2

This section deals with immunity to electrostatic discharge (ESD), which is a very difficult subject. Unlike, for example, emissions from a high-speed switching device, ESD is usually a random chance event, caused by a charged body (which may be somebody) coming close to, or touching, a point on the surface (or, in the case of *inter alia* servicing, the interior) of a product. In fact, 'close' may not be necessary; there is a possibly apocryphal story of Band 1 TV reception in Brighton suffering interference that was traced to the students at Roedean girls' public school discarding nylon underwear *en masse* at bedtime. It's certainly true that the TV signal, from Alexandra Palace in those days, was very weak in Brighton.

Once a discharge event has occurred, it's impossible to know where the energy went unless it causes detectable damage, and in many cases, it's a mystery how the discharge current get back to the high-voltage source. No-one really knew how the test equipment and the devices made to verify its operation actually behaved until oscilloscopes with bandwidths of several gigahertz became available. At that time, some people wanted to improve the test equipment but this was resisted on the grounds that it actually offered very little advantage over the existing equipment and might lead to new results inconsistent with previous ones.

The EMC consultant and lecturer Douglas C Smith has published a large amount of very interesting experimental data on ESD and other EMC subjects, which can be traced through http://emcesd.com/

IEC 61000-4-3

This Section covers immunity to radio-frequency fields, to which almost all equipment is continuously exposed. This subject has probably been studied longer than any other in EMC, so the methods and requirements are well established. Measurement in the open air is no longer legally possible, so an anechoic chamber is required. These, of course, are large and costly, so other methods have been developed which are the subjects of later Sections.

IEC 61000-4-4

The subject here is immunity to 'electrical fast transients/bursts'. Such transients occur on the public mains supply due to switching and other events. Sixty years ago, equipment was generally much more resistant to high-voltage transients, so there was no need for any testing, but there is now. Direct-on-line selenium rectifiers, replacing vacuum rectifiers, had stacks of diodes in series, so were also resistant to transients, and it came as a bit of a surprise how high the peak inverse voltage rating of single-junction silicon rectifiers had to be in order to achieve adequate reliability.

IEC 61000-4-5

This Section is about a 'surge immunity test'. Surges can occur on power supply cables and on signal cables, especially if they leave a building. This is another case where equipment has become much less inherently resistant over the years.

IEC 61000-4-6

Much equipment is too small, and too close to the ground, to act as an efficient receiving antenna for potentially disturbing radio-frequency signals, but cables can be fairly efficient antennas. In that case, the radio-frequency energy is presented to the equipment as conducted currents. The test methods require the use of 'coupling and decoupling devices' to control where those currents flow. Unfortunately, while these devices are fairly simple, many different types are required, not only to suit different cables but also to accommodate the huge number of different connectors that are used these days.

In the past, the standard did not cover 9 kHz to 150 kHz, but that frequency range is now covered in the 2008 edition.

IEC 61000-4-7

This is described as a 'general guide' and it started out that way, but it is now a specification for a measuring instrument for power system harmonic currents and voltages. The title may be changed in a future edition. Measuring harmonics of 50 Hz or 60 Hz sounds an easy task, but in fact there are many complications. Some transient high levels of harmonics are not considered unacceptable so can either be averaged out or, in other cases, specifically accepted. Also, the instruments are now digital, so special precautions are necessary to overcome certain 'features' of the Digital Fourier Transform, used to perform the frequency analysis.

The standard includes provisions for 'grouping' interharmonics (signals at non-harmonic frequencies) with adjacent harmonics by using a measurement bandwidth of 50 Hz or 60 Hz, but this has been found to be too stringent for some equipment which is in use without causing significant interference. So those provisions are at present suspended, by allowing the use of a method of measurement, with a 5 Hz bandwidth, that does not include grouping. Work is actively in progress to try to eliminate that, but it has so far proved too difficult. Maybe one day....

IEC 61000-4-8

Power frequency magnetic fields can cause many problems; obviously audio equipment in various forms may be particularly affected, but so can video displays and any equipment that handles very small voltages or currents may be disturbed by induced currents in conducting loops. The recommended test levels of continuous field strength range from 1 A/m to 100 A/m, but anything above 5 A/m is now considered inadvisable for human exposure in this frequency range. For fault conditions, the highest value is 1000 A/m, and even though that is supposed to last for no more that 3 seconds, i.e. until the fault is cleared by a protective device, the bioelectric effects (nerve stimulation by induced currents) are considered to act in time scales of tens of milliseconds.

The magnetic fields are supposed to be generated by large (1m square and 1 m by 2.6 m) single-turn coils, which require hundreds and even thousands of amps to produce the required field strengths, but the standard does allow other coil configurations to be used, provided that field strength is verified. It is a bit surprising that the test procedure requires a ground plane, but not necessarily a very large one. It isn't clear what the ground plane is supposed to do.

IEC 61000-4-9

The subject of this Section is a 'pulsed magnetic field immunity test', which is considered applicable only to products installed in electrical power plants.

IEC 61000-4-10

This Section is about another 'power plant' phenomenon, 'damped oscillatory magnetic field immunity test'. It is interesting that neither this Section or the previous one are called up in IEC TS 61000-6-5, Generic TS for immunity for power- and sub-station environments. However, that publication is under review and may become a standard that **does** reference IEC 61000-4-9 and -10.

I think ten Sections is enough for now, so look forward to further excitement next time. The last Section at present is IEC 61000-4-38, but not all of the numbers have been used.

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